Appendix F
METHODOLOGY FOR DEMAND ESTIMATES AND PROJECTIONS

CATEGORIES OF WATER USE

An important aspect in the development of water supply plans is the development of reliable water use estimates and projections. In the Kissimmee Basin (KB) Planning Area, demand assessments were made for 1995 and 2020 for the following water use categories:

- Public Water Supply
- Domestic Self-Supply
- Recreational Self-Supply
- Thermoelectric Power Generation Self-Supply
- Agricultural Self-Supply

The following discussion provides the details on how the District approached the development of projections for each of these water use categories. The first four categories are urban water uses and are discussed in the Urban Demand section of this appendix. The Agricultural Demand section contains the discussion of the agricultural self-supply water use category.

Water demand projections for the year 2020 included analyses under both 1-in-2 (average) rainfall conditions and 1-in-10 drought year conditions. Rainfall analysis is presented in Appendix B. Projections are based on current trends and circumstances and therefore imply an extension of current production, market, and legal circumstances.

The KB Planning Area contains part of six counties: Okeechobee, Orange, Osceola, Polk, Highlands, and Glades. The portions of these counties within the KB Planning Area will be referred to as county areas. Much of the data used to estimate water demands is available only at the county level. This data was adjusted so that the demands reported within this document are for the KB Planning Area only.

URBAN DEMAND

Public Water Supply and Domestic Self-Supplied

Public water supply (PWS) and domestic self-supply (DSS) demand assessments and projections have been developed for the District for 1995 and 2020. The DSS category includes small public supply systems with projected demands of less than 100,000 GPD as well as residents that supply their own water needs. Self-supplied residents may be either within utility boundaries or outside of utility boundaries (rural self-supplied).

The utility service areas used in this analysis were retrieved from the individual service utilities and interpolated into the District Geographic Information Systems (GIS) database. These service areas are shown in **Figures 12** through **14** in Chapter 9 of the Support Document. Adjustments were made to account for the future expansion of the current service areas. It was assumed that all new population growth within utility service area will be connected to a public water supply (PWS) system. Current domestic self-supplied (DSS) demand within a utility service areas was assumed to remain constant.

Population Estimates

1995 Estimates

U.S. Census data for 1995 were used as the basis for the 1995 permanent population and the distribution of that population. Block group level information from the 1995 estimated census count was used as the basic unit of analysis. Total population, total housing units, occupied housing units, and persons per occupied housing unit were retrieved from census data. The total units connected to a PWS system and total units self-supplied were obtained from the census data (U.S. Bureau of the Census, 1995).

Estimates of occupied units connected to PWS systems and occupied units that are self-supplied were calculated for each block group. It was assumed that the percentages of units occupied and the number of occupants per unit were the same for both PWS connected and DSS units. PWS and DSS block group populations were calculated by multiplying the number of occupied units by the number of persons per occupied unit for the respective block group (**Equation F-1**).

Block group population = Occupied units x *Persons per occupied unit* *(F-1)*

The geographic areas represented by the census block groups and the utility service areas were input as polygon coverages into the District's Geographic Information System (GIS). Population density for those areas served by a PWS and those self-supplied were calculated for each block group generally assuming a uniform density within each. Satellite imagery was used to review decisions if necessary. The two coverages, census block group populations and utility service areas, were overlaid to create a polygon coverage with the attribute data from both coverages. PWS and DSS population assessments were then calculated for the new polygon coverage by multiplying the polygon area by the population density (**Equation F-2**). The permanent populations for each area were then totaled.

Permanent population for area = Polygon area x *Population density* *(F-2)*

Any growth in population within a utility service area was assigned to that utility and the DSS population was assumed to remain the same. Any growth in population within an area not being served by a utility was assigned to the rural self-supplied category. The method assumes a uniform density in the polygons. In certain area where urban densities are adjacent to very low intensity development or undeveloped areas and where the block group is split by a service area boundary, it is possible to underestimate the population in the developed area and to overestimate the population in the less developed area. For purposes of this analysis, no adjustments were made to redistribute populations in urbanized Orange County and in areas served by larger PWS utilities in Osceola County. However, adjustments were made for smaller PWS utilities in Osceola, Polk and Okeechobee counties. Application of the GIS was determined to be unnecessary for rural and low density areas in Glades, Highlands, Okeechobee, and Polk counties.

2020 Projections

Local comprehensive plan population data were used as the basis for population projections for 2020 (**Table F-1**). The geographic distribution of the 2020 population was determined using Traffic Analysis Zone (TAZ) population projections for the portion of the region covered by TAZs. The geographic distribution of the 2020 population for areas not covered by TAZs was determined from information in the individual county's comprehensive plans. Total population was controlled to the total from these local government comprehensive plans.

Table F-1. Population Estimates and Projections.[a]

County Area	1995 Population	2020 Population	% Change
Glades	3,289	5,640	71
Highlands	7,700	11,590	51
Okeechobee	28,737	45,244	57
Osceola	130,605	260,937	100
Orange	186,131	349,453	88
Polk	6,375	13,832	117
Total	362,837	686,696	89

a. Population numbers are from those county portions within the Kissimmee Basin Planning Area.

Source: SFWMD, Districtwide Water Supply Assessment, 1998.

The geographic areas represented by the TAZs, cities and the utility service areas were input as polygon coverages into the District's GIS. Population density was calculated for each TAZ assuming a uniform density within each zone. The coverages were joined to create a new polygon coverage with the attribute data from the original coverages. Population estimates were then recalculated for the new polygon coverage by multiplying the area of the polygon by the population density. The populations for each service area were then totaled and controlled to local comprehensive plan projections totals. Since Glades, Highlands and Okeechobee counties do not have TAZs, 2020 population distribution, where necessary, was made on the basis of the future land use maps of the counties' comprehensive plans.

Per Capita Rates

Per capita water use rates for each utility were estimated by dividing raw water pumped by the population served by public water supply utilities:

Per capita water use rates = Raw water pumped/Population served *(F-3)*

It was determined that water exchanged between utilities as a result of wholesale agreements was not a significant portion of the total water use and is therefore not factored into this estimate. Raw water withdrawal data was provided by the U.S. Geological Survey (USGS) who in turn obtained the information from the FDEP and the local utilities. Population and the number of individuals served by the utilities were determined by the above-mentioned methodology. Per capita rates were estimated for 1995 and were used for 2020 projections. For Reedy Creek PWS system, "per day visitor" rate was estimated and used for 2020 projection.

Self-supplied water use rates were assumed to be the same as the utility in that service area. The per capita rates for these areas were assumed to be the same as the PWS per capita rates for the adjoining county/city utility service area.

In estimating the per capita water rates for 1995, water used by seasonal residents was included in the use data. Irrigation demand for PWS served households using private well water for their irrigation is considered to be very small and was not estimated.

Demand

Demand was defined as population times per capita water use rate:

Demand = Population x *Per capita rate* *(F-4)*

For each service area, a PWS demand and a DSS demand were estimated for 1995. A PWS and DSS demand for each service area were also projected for 2020. For 2020, it was assumed that all population growth within each service area will be provided potable water by the PWS utility. Current self-supplied demand within the service areas was assumed to remain at its 1995 levels. In addition to the utility service areas, demand estimates for 1995 and demand projections for 2020 for self-supplied areas were made. These self-supplied areas are not currently served by a PWS utility and no utility has been identified that will serve these areas in the future.

Summary

Using the above-stated methodology, the total population estimates for the KB Planning Area for 1995 was 362,837. The projected total population for 2020 is projected to increase to 686,696. In 1995, the estimated total water demand for PWS and DSS was 71.3 and 8.26 million gallons per day (MGD), respectively. In 2020, it is projected that the PWS demand will increase to 145.3 MGD and the DSS demand will increase to 11.8 MGD.

Table F-2 shows the per capita water use rate for each service area, the population estimates, and the resulting water demand for 1995. **Table F-3** shows the per capita water use rate for each service area, the population projections, and the resulting water demand for 2020.

Table F-2. Population and Actual Water Use for 1995.

Service Areas	PWS Population	PWS Use (MGD)	GPCD	DSS Population	DSS Use	Total Service Area Population	Total Service Area Use (MGD)
Osceola County							
Florida Water Services[a]	0	0.00	101	3,189	0.37	3,189	0.37
Poinciana	9,724	1.74	178	0	0	9,724	1.74
Buenaventura Lakes	19,481	1.82	98	366	0.04	19,847	1.9
St. Cloud	20,387	2.21	93	0	0	20,387	2.21
Kissimmee	52,588	13.54	265	0	0	52,588	13.54
Rural	0	0.00	156	28,059	4.4	28,059	4.4
Orange County							
Taft	0	0.00	135	2,073	0.28	2,073	0.28
Orlando Utilities Commission	131,530	27.45	208	0	0	131,530	27.45
Orange County Utilities[b]	54,601	6.56	158	0	0	54,601	6.56
Reedy Creek[c]	0	15.21	0	0	0.00	0	15.21
Rural	0	0.00	319	4,687	1.50	4,687	1.50
Highlands County							
Rural	0	0.00	105	7,700	0.81	7,700	0.81
Glades County							
Rural	0	0.00	127	3,289	0.42	3,289	0.42
Okeechobee County							
Okeechobee Utility Authority	21,200	1.92	92	0.00	0	0	1.92
Rural	0	0.00	92	7,537	0.69	7,537	0.69
Polk County							
Oak Hill Estates	5,212	0.79	152	0	0	5,212	0.79
Rural	0	0.00	152	6,375	0.18	6,375	0.18

a. Florida Water Utilities includes seven smaller utilities in addition to Buenaventura Lakes.
b. Rural in county is a part of county service area.
c. Reedy Creek's use is based on 99,700 "Day Visitors".

Commercial and Industrial

The employment by sector was evaluated regarding the predominant types of employment found in the county, and if these employment types could be expected to

Table F-3. Population and Projected 2020 Average Water Use.

Service Areas	PWS Population	PWS Use (MGD)	GPCD	DSS Population	DSS Use	Total Service Area Population	Total Service Area Use (MGD)
Osceola County							
Florida Water Services[a]	6,500	0.64	100	0	0	6,500	0.65
Poinciana	36,718	3.27	93	889	0.08	37,607	3.42
Buenaventura Lakes	20,380	2.12	98	0	0	20,380	2.2
St. Cloud	35,788	3.06	93	0	0	35,788	3.16
Kissimmee	114,787	28.92	265	0	0	114,787	29.42
Rural	0	0.00	156	52,375	6.8	52,375	6.8
Orange County							
Taft	0	0.00	135	2,175	0.29	2,175	0.29
Orlando Utilities Commission	210,827	43.35	208	3,688	0	210,827	44.2
Orange County Utilities[b]	138,218	21.84	158	10,714	0	138,218	20.23
Reedy Creek[b]	0	34.0		0		0	34.0
Rural		0.00	319	3,920	1.25	3,920	1.25
Highlands County							
Rural	0	0.00	105	11,590	1.28	11,590	1.28
Glades County							
Rural	0	0.00	127	3,289	1.16	3,289	1.18
Okeechobee County							
Okeechobee Utility Authority	33,258	3.64	90	4,839	0	33,258	3.06
Rural	0	0.00	92	11,976	1.09	11,976	1.09
Polk County							
Oak Hill Estates	12,238	1.85	152	0	0	12,238	1.85
Rural	0	0.00	152	1,594	0.24	1,594	0.24

a. Florida Water Utilities includes seven smaller utilities in addition to Buenaventura Lakes.
b. Rural in county is a part of county service area.

grow at the same rate and in the same direction as the population. In the KB Planning Area, the majority of the employees are found in the service and retail sales sectors, indicating that water demand by these sectors will generally grow along with the population. Water used for commercial and industrial purposes supplied by utilities are included with other utility demands. Self-supplied commercial and industrial demands are shown in **Table F-4**. Industrial self-supplied water use was assumed to increase at the same rate as the county population, with 1995 used as the base year.

Table F-4. Commercial and Industrial Self-Supplied Demand (MGY).

County Area	1995	2020	% Change
Orange	799	1,263	58
Osceola	266	533	100
Polk	234	321	37
Highlands	0	0	0
Okeechobee	0	0	0
Glades	0	0	0
Total Kissimmee Basin	1,299	2,117	63

Recreation Self-Supplied

Landscape

Demand projections for this section include irrigated acreage permitted for landscaping and recreation, excluding golf courses. Landscaping water use was assumed to increase at the same rate as the county population, with 1990 used as the base year. Projections for landscaping self-supplied demand are outlined in **Table F-5**.

Table F-5. Landscape and Recreational Self-Supplied Demand (MGY).

County Area	1995	2020	% Change
Orange	3,106	4,071	11
Osceola	497	2,147	276
Polk	278	436	44
Highlands	1,268	1,918	52
Okeechobee	100	122	22
Glades	0	0	0
Total Kissimmee Basin	5,249	8,694	66

Golf Course

There are golf courses in the Orange, Osceola, Polk, and Okeechobee county areas. Highlands and Glades counties also have golf courses, but they are in other planning areas or in areas outside of the District.

Historical irrigated golf course acreage data were gathered from the Florida Golf Guide (Florida Dept. of Commerce, 1990, 1991), Golf Guide To The South (Florida Golfweek, 1989), The Golf Course (Cornish and Whitten, 1988), and personal communication with several of the golf courses listed. Golf course irrigation requirement estimates were made by time horizon and month.

Orange County

As of 1995, there were 37 golf courses with a combined irrigated acreage of 4,655 acres in Orange County. These golf courses are outlined in **Table F-6**. Of these 37 golf courses, 20 lie within the KB Planning Area and eight are supplied be with reclaimed water.

Table F-6. Golf Courses in Orange County.

Name	Year Open	Total Acres	Irrigated Acres
Bay Hill Golf Course[a]	1964	200	180
Country Club of Orlando	1921	166	120
Cypress Creek Country Club[a]	1970	120	120
Deer Run South	1972	100	80
Disney World (Magnolia)[a]	1971	180	160
Disney's Bonnet Lakes[a]	1991	160	145
Disney's Lake Buena Vista Club[a]	1972	145	145
Dubsdread	1922	100	50
Errol Country Club	1971	150	150
Fairways Country Club	1972	540	540
Golf World Driving Range and Par 3	1988	18	13
Grand Cypress Golf Course[a]	1983	1,531	477
Greens Golf, The (Cannongate)[a]	1968	60	35
Hunter's Creek Golf Course[a]	1986	150	149
Interlachen Country Club, The[a]	1985	270	110
International Golf Course[a]	1987	138	110
Isleworth Golf and Country Club[a]	1986	179	179
Lake Nona Club[a]	1986	100	100
Mariott's Orlando World Golf Course[a]	1986	193	95
McCoy Annex[a]	1981	40	30
Meadow Woods Country Club[a]	1985	105	105
Metro West[a]	1987	180	109
Naval Training Center Golf Course (Crows nest)	1962	45	35
Naval Training Center Golf Course	1990	40	30
Orange Lake Country Club[a]	1982	350	238

Table F-6. (Continued) Golf Courses in Orange County.

Name	Year Open	Total Acres	Irrigated Acres
Orange Tree Country Club[a]	1973	104	85
Orangewood East Golf Course[a]	1987	196	138
Rio Pinar Country Club	1958	150	100
Rosemont Golf and Country Club	1972	120	120
Sweetwater Country Club	1974	136	105
Ventura Country Club	1980	500	150
Wedgefield Golf and Country Club (Cape Orlando)	1965	120	100
West Orange Country Club	1967	146	100
Windermere Country Club[a]	1986	155	140
Winter Park Country Club	1916	27	27
Winter Pines Golf Course	1965	90	26
Zellwood Station and Country Club	1974	121	59
Total		7,125	4,655

a. In the Kissimmee Basin Planning Area.

Historical golf courses were ordered by year of golf course opening and irrigated acres in existence. When this had been done the model shown in **Equation F-5** was estimated:

$$CUMACRES_t = f(Pop_t, d) \qquad (F\text{-}5)$$

where:

$CUMACRES_t$ = *the cumulative irrigated golf course acreage present in year t*

Pop_t = *the permanent resident population in year t*

d = *a dichotomous variable equal to 1 from 1972 through 1974, and 0 otherwise*

Golf courses open in discrete units, so that acreage tends to increase in jumps, rather than increasing along a smooth path. Thus, the acreage present at any point in the future will be sensitive to the timing of future golf course openings, which cannot be predicted with accuracy. The projections presented here should be interpreted in the light of the absence of specific data on the timing of the opening of new golf courses. However, these projections depict the long-term trends in Orange County golf course acreage.

Equation F-5 was estimated using ordinary least squares regression analysis, resulting in **Equation F-6**, which was used to develop the primary projection for irrigated golf course acreage in Orange County. Projected self-supplied (using fresh water) golf course acreage is expected to increase from the 3,592 acres in 1995 to an estimated 3,749 acres in 2020.

$$CUMACRES_t = -2884.401 + 11.501 * Pop_t + 246.811 * d \qquad (F\text{-}6)$$

$$(33.42) \quad (2.32)$$

Goodness of fit statistics:

R^2=.9739
F= 79.21
Pr F > 0 >.999
D-W = 0.901
t-statistics in parentheses

Osceola County

In 1995 there were nine golf courses in Osceola County, all within the District. Three of these courses were supplied by reclaimed water. The remaining six courses totaled 541 irrigated acres. These are described in **Table F-7**.

Table F-7. Golf Courses in Osceola County.

Name	Year Opened	Total Acres	Irrigated Acres
Kissimmee Golf Course (Airport Inn)	1965	100	100
Buenaventura Lakes Country Club	1975	65	65
Crystal Brook Golf Course	1979	18	2
Buenaventura Lakes Country Club West	1983	130	130
Overoaks Country Club	1985	170	159
Kissimmee Bay	1990	270	85
Total		753	541

Osceola County irrigated golf course acreage has increased rapidly in recent years, increasing from 100 acres in 1965 to 753 acres in 1995. During this same period, there was also a large increase in Osceola County population. In order to project Osceola County golf course acreage, a model of the form shown in **Equation F-7** was developed.

$$LOGACRES_t = f(LOGTIME_t, LOGPOP_t) \qquad (F\text{-}7)$$

where:

$LOGACRES_t$ = *common logarithm of cumulative golf course acreage in Osceola County in year t*

$LOGTIME_t$ = *common logarithm of the variable TIME in year t, where TIME takes on a value of one in 1965 and increases by one unit each year thereafter*

$LOGPOP_t$ = *common logarithm of Osceola County population in year t. Historic data came from the Bureau of Economic and Business Research (BEBR) and the U. S. Bureau of the Census; projected population came from the BEBR. Years for which populations were not available were linearly interpolated.*

When **Equation F-7** was estimated empirically using ordinary least squares the results shown in **Equation F-8** were obtained.

$$LOGACRES_t = -1.285 + .2277 * LOGTIME_t + .7558 * LOGPOP_t \qquad (F\text{-}8)$$

$$(3.84) \ (6.17)$$

<u>Goodness of fit statistics:</u>

R^2 =.9880
F = 164.82
Pr F > 0 >.999
D-W = 2.676
t-statistics in parentheses

In order to calibrate the projections to 1990 acreage, the residual between predicted and actual acreage for 1990 (17 acres) was subtracted from the projections for 1991 and thereafter. When Osceola County irrigated golf course acreage was projected using **Equation F-8**, adjusted as described. The results of this analysis show that 2,704 acres are projected for the year 2020.

Polk County Area

There are currently three golf courses within the District in eastern Polk County totalling about 215 irrigated acres. These are described in **Table F-8**.

No meaningful trend can be developed due to the small number of golf courses in the Polk County Area. District staff have been notified that one course is planned by a community over the next 20 years. This will bring the total irrigated acreage to an estimated 365 acres for the year 2020.

Table F-8. Golf Courses in the Polk County Area.

Name	Year Open	Total Acres	Irrigated Acres
Grenelefe Golf and RC	1972	184	15
Poinciana Golf and RC	unknown	200	120
Sun Air Country Club	1976	80	80
Total		464	215

Okeechobee County Area

There are currently two golf courses in Okeechobee County, both of which are within the District. These are described in **Table F-9**.

Table F-9. Golf Courses in Okeechobee County.

Name	Year Open	Total Acres	Irrigated Acres
Okeechobee Golf and Country Club	1966	69	31
Okeechobee KOA (Crystal Lakes)	1968	57	57
Total		126	88

No meaningful trend can be developed due to the small number of golf courses in Okeechobee County. Therefore, irrigated golf course acreage was projected to remain constant through the year 2020.

AGRICULTURAL DEMAND

There are no whole counties contained entirely within the KB Planning Area. Orange, Osceola, Polk, Glades, Highlands, and Okeechobee counties are divided between the SFWMD and other water management districts and other planning areas of the SFWMD. Crop acreage projections were needed specifically for those county portions which fall in the KB Planning Area. To do this often necessitated projecting crop acreages for the entire county and then apportioning these projections between water management districts and planning areas within the SFWMD. This was done by assuming changes in crop acreage were proportional to the most recently reported acreage ratios. Acreage ratios were developed with the use of District land use maps and with the cooperation of the local IFAS extension offices.

The techniques chosen to project crop acreages were those judged to best reflect the specific crop scenario in each county. This led to some variation in projection techniques between crop types, and in method between counties. While it would have been ideal if a comprehensive functional form could have been found which produced tangible projections universally, no such functional form was found. The acreage projections developed here reflect a combination of methods, each of which deemed appropriate where used.

In some cases, a single mathematical model could be chosen as it accurately explained past trends, and was judged as clearly the most reasonable scenario for the future. In other cases, several models accurately explained past trends, and none of these provided explicitly more likely projections than the others. In these cases, the projections of several statistically valid and empirically sound models were averaged. This approach was justified by research performed at the Bureau of Economic and Business Research (Mahmoud, 1984) which showed that taking the average of a number of different projections reduces the chances of making large errors and leads to more reliable projections.

When no statistically valid trend was found, or any convincing empirical knowledge of future changes in a crop's acreage, then the specific crop's acreage was projected at its most recently reported value (+/- 15 percent) for future time horizons. Usually these situations arose from relatively insignificant.

Agricultural irrigation and cattle watering demand estimates were made by time horizon and month. Average and 1-in-10 irrigation requirements were calculated by month using the District's modified Blaney-Criddle permitting model. Historical weather data from the rainfall station most frequently used by the District to permit each crop/county combination were used to calculate irrigation requirements.

A crop's supplemental water requirement is the amount of water used for evapotranspiration minus effective rainfall, while irrigation requirement includes both the supplemental water requirement and the losses incurred in getting irrigation to the crop's root zone. Irrigation efficiency refers to the average percent of total water applied that is stored in the plant's root zone. This relationship is expressed as follows:

Irrigation requirement = Supplemental water requirement / Irrigation efficiency *(F-9)*

Projections of irrigation system type, and the effect of the corresponding irrigation efficiencies, were based on the interpretation of current ratios and trends. There are three basic types of irrigation systems currently used in crop production. These are seepage (50 percent), overhead sprinkler (75 percent), and micro irrigation (85 percent) systems. The irrigation efficiencies estimated by the District are shown in parentheses.

Soil type, with regard to water use permitting by the District, refers to the soil's usable soil water capacity. Usable soil water capacity has a direct affect on effective rainfall. For each crop type assumptions for soil type were made for present and future acreage based on the most commonly District permitted crop/soil type combination in the county. The District classifies five types of soil with regard to usable soil water capacity in inches, i.e., 0.2, 0.4, 0.8, 1.5, and 3.6. The percentage of each soil type in each county area is indicated in **Table F-10**. The locations of these soils in the KB Planning Area are shown in **Figures F-1a** and **F-1b**.

Table F-10. Soil Types in the Kissimmee Basin Planning Area.

Soil Type (in.)	Percentage of Total for Each County Area					
	Orange	Osceola	Okeechobee	Polk	Highlands	Glades
0.2	51	19	0	1	0	0
0.4	30	0	0	8	6	2
0.8	7	49	77	73	70	91
1.5	10	32	19	18	11	6
3.6	2	0	4	0	13	1
Total[a]	100	100	100	100	100	100

a. Percent of total county area within the Kissimmee Basin Planning Area.

Crop Types

The irrigated commercially grown crops in the KB Planning Area are citrus, vegetables, sod, blueberries, caladiums, and ornamental nursery. Improved pasture is rarely irrigated, but there are some demands for cattle watering.

Citrus

All categories of citrus (oranges, grapefruit, tangerines, etc.) were grouped together for projection purposes. Historical citrus acreage data were gathered from volumes of the Commercial Citrus Inventory (Florida Agricultural Statistics Service, Various Issues), which is published biennially.

In counties with declining citrus acreage a curvilinear model of the form shown in **Equation F-10** was used to project citrus acreage. The precise functional form varies from county to county, but in general a logarithmic or semi-logarithmic functional form was used. A dichotomous variable is included to reflect the importance of unique events, particularly freezes, in determining the pattern of decline. The importance of these unique events must be kept in mind in interpreting acreage projections, since future freezes or other dramatic events are not incorporated in the models.

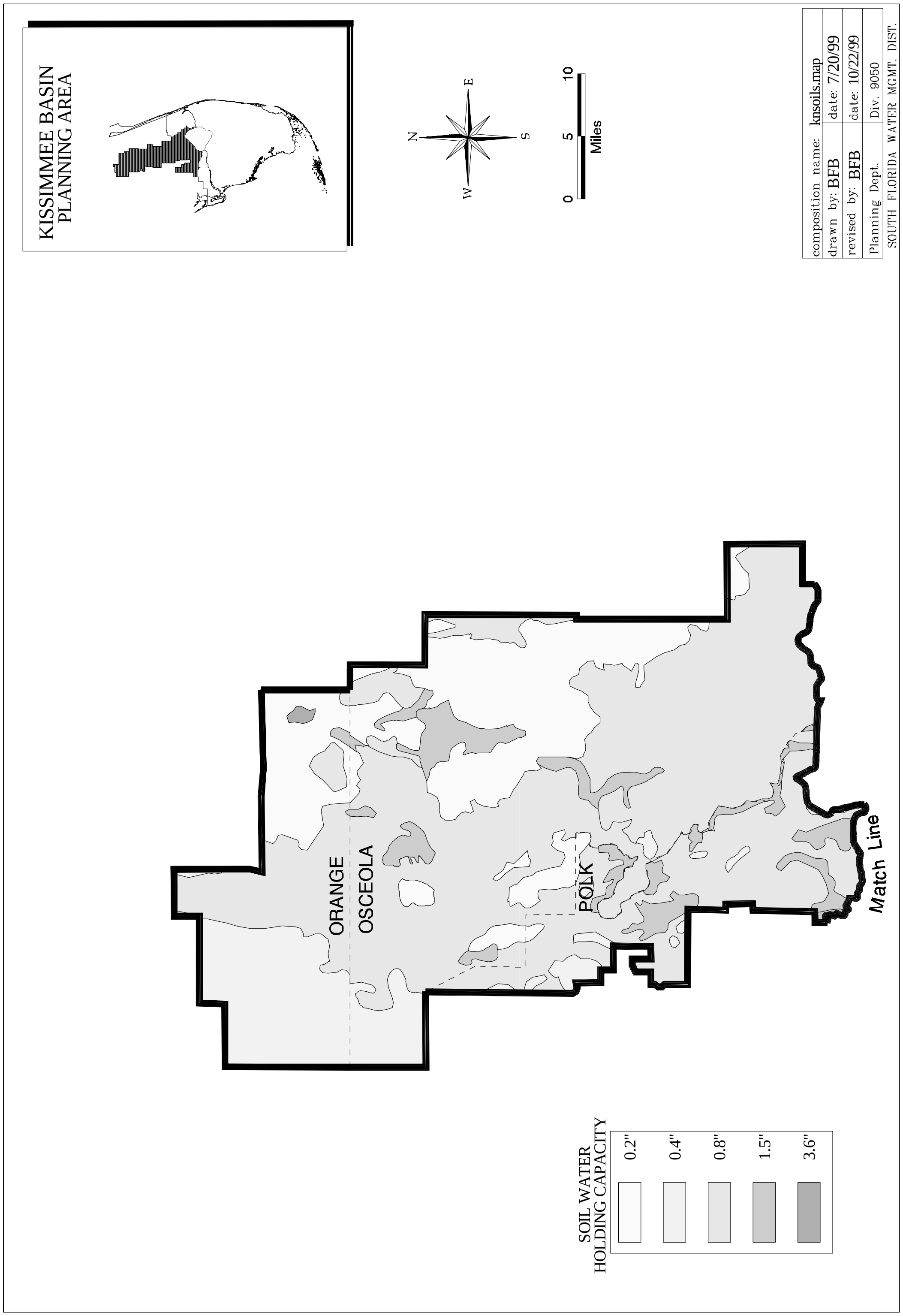

Figure F-1a. Location of Soil Types in the North Kissimmee Planning Area.

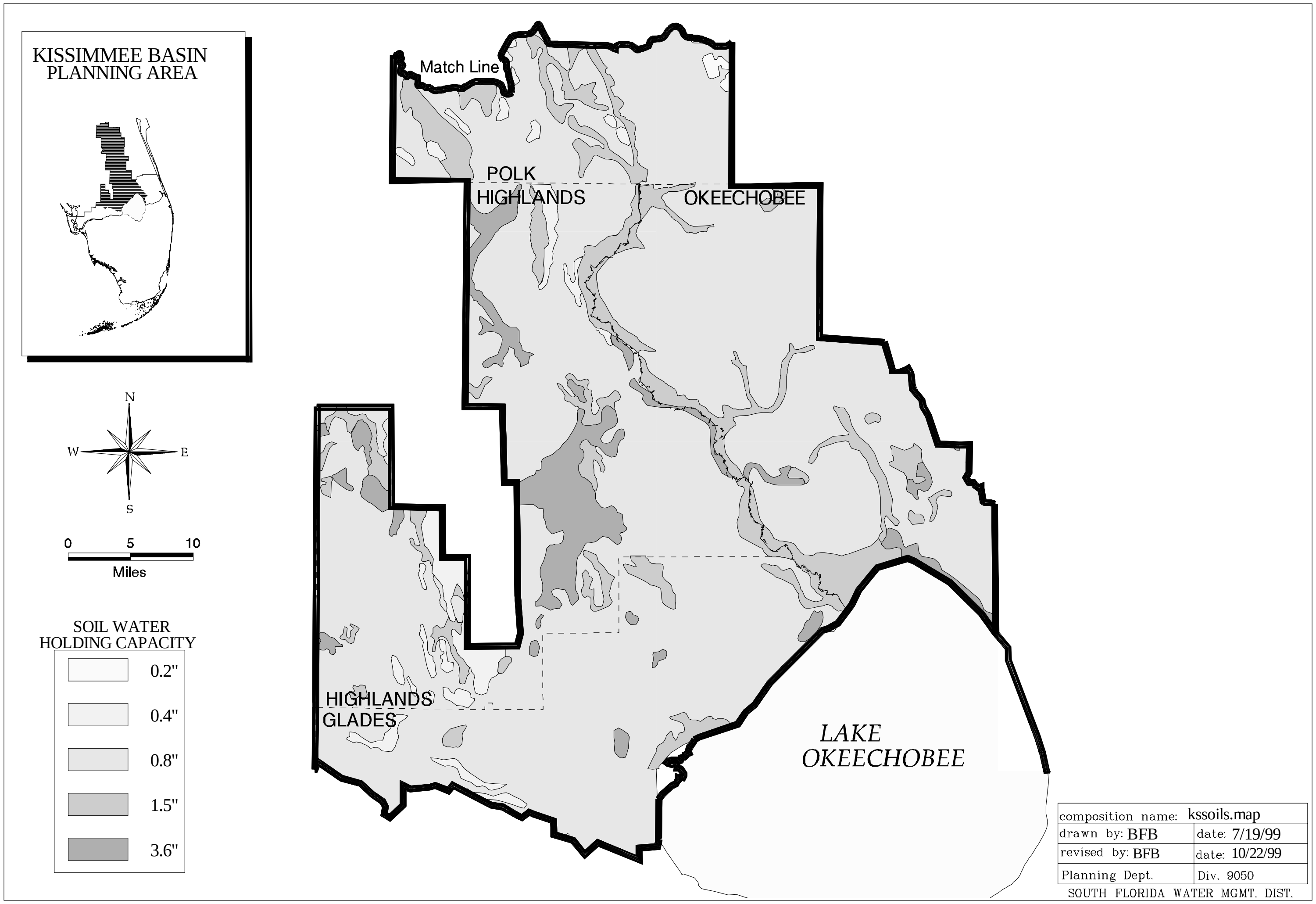

Figure F-1b. Location of Soil Types in the South Kissimmee Planning Area.

$$LOGA_t = f(time, d) \tag{F-10}$$

where:

$LOGA_t$ = *the common logarithm of citrus acreage in year t*

time = *One in 1966 and increases one unit each year thereafter*

d = *a dichotomous variable*

In counties where citrus acreage is increasing, models of the general form of **Equation F-11** were used for projection purposes.

$$A_t = f(P_p, P_w, P_o, t, d) \tag{F-11}$$

where:

A_t = *County citrus acreage in year t*

P_p = *the real price of pink grapefruit (by region) in year t*

P_w = *the real price of white grapefruit (by region) in year t*

P_o = *the real price of round oranges (by region) in year t*

t = *time trend variable, one in 1966 and increasing by one unit per year*

d = *a dichotomous variable*

The dichotomous (d) variable was designed to capture the interregional shift in citrus production as a result of severe winters in the citrus producing areas of Central Florida. Models were run which weighted all observations equally, and also with the weight declining geometrically with time - with the lowest weight being assigned to the earliest observation (denoted as $WCIT_t$). Eight specific sub-models were estimated as shown in **Equations F-12** through **F-19**.

$$CIT_t = f(time, RP_o, RP_p, RP_w, d) \quad (F\text{-}12)$$

$$WCIT_t = f(time, RP_o, RP_p, RP_w, d) \quad (F\text{-}13)$$

$$CIT_t = f(time, d) \quad (F\text{-}14)$$

$$WCIT_t = f(time, d) \quad (F\text{-}15)$$

$$CIT_t = f(time, RP_o, RP_p, RP_w) \quad (F\text{-}16)$$

$$WCIT_t = f(time, RP_o, RP_p, RP_w)(\quad (F\text{-}17)$$

$$CIT_t = f(time) \quad (F\text{-}18)$$

$$WCIT_t = f(time) \quad (F\text{-}19)$$

Note that for the initial sets of projections, there were no attempts made to project changes in the exogenous variables (other than time) the major difference in forecasts results from differences in the estimates of the coefficient on the time variable.

Orange County Area

Citrus acreage in Orange County has been severely reduced by freezes and a general model of the form shown in **Equation F-10** was utilized for projection purposes. Models were estimated using both ordinary least squares and robust regression. The two models estimated for Orange County are given in **Equation F-20** (ordinary least squares) and **Equation F-21** (robust regression).

$$LOGORA_t = 4.883 \text{ -}.0138 * time \text{ -}.4594 * d \quad (F\text{-}20)$$

$$(-3.41) \qquad (-6.42)$$

Goodness of fit statistics

$R^2 = .9659$
$F = 169.73$
$Pr\ F > 0 > .999$
$D\text{-}W = 1.860$
t-statistics in parentheses

where:

$LOGORA_t$ = *the common logarithm of Orange County citrus acreage in year t*

time = *One in 1966 and increases one unit each year thereafter*

d = *a dichotomous variable equal to zero in 1984 and before and one in years after 1984*

$$LOGORA_t = 4.8646 - .0115 * time - .4838 * d \qquad \text{(F-21)}$$

$$(-7.09) \qquad (-14.96)$$

Goodness of fit statistics

$R^2 = .9910$
$F = 604.72$
$Pr\ F > 0 > .999$
$D\text{-}W = 1.819$
t-statistics in parentheses

Table F-11. Historical Citrus Acreage in Orange County.

Year	Historical
1966	65,817
1968	68,005
1970	65,961
1972	60,567
1974	56,320
1976	54,007
1978	51,174
1980	50,673
1982	48,547
1985[a]	16,670
1986	14,692
1988	17,356
1990	8,399
1991[b]	8,098
1992	9,470
1994	10,402
1995	10,072

a. Because of severe freezes, no 1984 acreage data for Orange County was reported by the Florida Agricultural Statistics Service.
b. Special survey for 1991.

Osceola County Area

As in other counties with declining citrus acreage a curvilinear model of the form shown in **Equation F-10** was used to project citrus acreage. The two models estimated for Osceola County are given in **Equation F-22** (ordinary least squares) and **Equation F-23** (robust regression).

$$LOGOSC_t = 4.300 - .0790 * logtime - .0661 * d \qquad (F\text{-}22)$$

$$(-5.39) \qquad (-5.21)$$

Goodness of fit statistics

$R^2 = .8682$
$F = 39.52$
$Pr\ F>0 = .999$
$D\text{-}W = 2.029$
t-statistics in parentheses

where:

$LOGOSC_t$ = *the common logarithm of Osceola County citrus acreage in year t*

logtime = *the common logarithm of the variable time, where time takes on a value of 1 in 1966 and increases one unit each year thereafter*

d = *a dichotomous variable equal to 1 in 1986 and 1988 and 0 in other years*

$$LOGOSC_t = 4.3002 - .0707 * logtime - .0729 * d \qquad (F\text{-}23)$$

$$(-9.09) \qquad (-3.59)$$

Goodness of fit statistics

$R^2 = .9019$
$F = 50.57$
$Pr\ F > 0 > .999$
$D\text{-}W = 1.916$
t-statistics in parentheses

To generate estimates of citrus acreage in the Osceola County Area, it was assumed that changes is acreage will be proportional to the 1990 acreages within the two districts. The 1990 IFAS estimate is that 7.5 percent of the citrus acreage in Osceola County is within the SJRWMD portion of the county, and the rest in the SFWMD. This ratio was used to project future citrus acreage for the Osceola County Area within the

District, which is shown in Table F-12. Citrus acreage is forecast to decline by an estimated 431 acres from 1995 to 2020.

The acreage ratio of the three different types of irrigation systems currently in use for citrus was assessed from District water use permits.

Polk County Area

In Polk County, as in other counties with declining citrus acreage a curvilinear model of the form in **Equation F-10** was used to project citrus acreage. Models were estimated using both ordinary least squares, shown in **Equation F-24**, and robust regression shown in **Equation F-25**.

$$LOGPOLK_t = 5.192 - .0525 * time - .1322 * d \qquad (F\text{-}24)$$

$$(-2.54) \qquad (-7.94)$$

Goodness of fit statistics

$R^2 = .9257$
$F = 80.94$
$Pr\ F > 0 > .999$
$D\text{-}W = 1.829$
t-statistics in parentheses

where:

$LOGPOLK_t$ = *the common logarithm of Polk County citrus acreage in year t*

time = *one in 1966 and increases one unit each year thereafter*

d = *a dichotomous variable equal to zero in 1985 and before and one in years after 1985*

$$LOGPOLK_t = 5.196 -.0564 * time - .1356 * d \qquad (F\text{-}25)$$

$$(-4.41) \qquad (-12.11)$$

Goodness of fit statistics

$R^2 = .9598$
$F = 155.38$
$Pr\ F > 0 > .999$
$D\text{-}W = 1.739$
t-statistics in parentheses

Table F-12 shows the historical citrus acreage in Polk County as a whole. To generate estimates of citrus acreage in the Polk County Area it was assumed that changes is crop acreage will be proportional to the current acreages within the two districts. Very little of the citrus acreage in Polk County is within the SFWMD. Appraisals from SWFWMD are that only 2.5 percent Polk County's citrus is within the District's boundaries. This percentage was used to project future citrus acreage for the Polk County Area. The estimated citrus acreage in the Polk County Area is shown in **Table F-13**. Citrus acres are expected to decline by approximately 440 over the next 20 years.

Table F-12. Historical Citrus Acreage in Polk County.

Year	Historical
1966	149,287
1968	150,244
1970	150,122
1972	144,153
1974	141,475
1976	137,693
1978	134,261
1980	132,124
1982	133,545
1984	129,912
1986	93,014
1988	108,546
1990	99,732
1991	86,882
1992	91,889
1994	104,007
1995	103,836

Table F-13. Historical Citrus Acreage in the Polk County Area.

	1985	1990	1995
Polk County Area	2,787	2,493	2,596

Highlands County Area

Citrus acreage is increasing in Highlands County. **Equations F-12** through **F-19**, estimated for Highlands County citrus acreage are presented in **Equations F-26** through **F-31**.

$$A_{ct} = 21534.61 + 866.9568 * t - 458.0132 * RP_o + 389.7242 * RP_p + 1744.513 * RP_w + 18551.82 * \qquad (F\text{-}26)$$

(3.18) (-0.33) (0.22) (1.32) (3.63)

Goodness of fit statistics

$R^2 = .8876$
$F = 14.22$
$Pr\ F > 0 > .999$
$D\text{-}W = 2.08$

$$WAct = -10235.54 + 2005.71 * t - 494.9358 * RPo - 418.8051 * RPp + 1693.219 * RPw + 19378.5 * d \qquad (F\text{-}27)$$

(7.98) (-0.39) (-0.26) (1.39) (4.11)

Goodness of fit statistics
$R^2 = .9733$
$F = 65.72$
$Pr\ F > 0 > .999$
$D\text{-}W = 2.16$

$$A_{ct} = 33502.46 + 598.3515 * t + 17870.26 * d \qquad (F\text{-}28)$$

(3.56) (4.18)

Goodness of fit statistics

$R^2 = .8593$
$F = 36.64$
$Pr\ F > 0 = .999$
$D\text{-}W = 1.63$

$$WA_{ct} = -3853.116 + 1806.578 * t + 19249.52 * d \qquad (F\text{-}29)$$

(11.58) (4.85)

Goodness of fit statistics

$R^2 = .9663$
$F = 172.04$
$Pr\ F > 0 > .999$
$D\text{-}W = 2.00$

$$Act = 28306.57 + 1196.031 * t - 2660.984 * RPo + 217.4507 * RPp + 2510.438 * RPw \qquad (F\text{-}30)$$

(3.12) (-1.46) (0.08) (1.29)

Goodness of fit statistics

$R^2 = .7224$
$F = 6.50$
$Pr\ F > 0 =.993$
$D\text{-}W = 0.80$

$$WAct = -3161.817 + 2349.448 * t - 2796.072 * RPo - 598.7551 * RPp + 2496.273 * RPw \qquad (F\text{-}31)$$

(6.15) (-1.54) (-0.23) (H-26) (1.28)

Goodness of fit statistics

$R^2 = .9231$
$F = 30.04$
$Pr\ F > 0 > .999$
$D\text{-}W = 0.74$

$$A_{ct} = 29662.48 + 1013.177 * t \qquad (F\text{-}32)$$

(4.95)

Goodness of fit statistics

$R^2 = .6540$
$F = 24.57$
$Pr\ F > 0 > .999$
$D\text{-}W = 0.33$

$$WA_{ct} = -\ 7989.471 + 2253.44 * t \tag{F-33}$$

$$(10.81)$$

<u>Goodness of fit statistics</u>

$R^2 = .9000$
$F = 117.06$
$Pr\ F > 0 > .999$
$D\text{-}W = 0.3569$

Table F-14 shows the historical citrus acreage in Highlands County as a whole. To generate estimates of citrus acreage in the Highlands County Area it was assumed that changes is crop acreage will be proportion to the most recently reported ratio of acreage within the two districts.

Table F-14. Historical Citrus Acreage in the Highlands County Area.

Year	Historical
1966	37,409
1968	39,110
1970	38,803
1972	37,765
1974	37,996
1976	37,375
1978	37,105
1980	37,767
1982	37,661
1984	44,030
1986	46,012
1988	48,569
1990	57,048
1992	62,217
1994	74,035
1995	76,138

In 1987, there were 30,800 acres of citrus in the SWFWMD portion of Highlands County (Reynolds et. al., 1990). This figure is 65 percent of the total acreage of citrus in Highlands County in 1987, and infers that the remaining 35 percent was in the District in 1987.

This ratio was used to project future citrus acreage for the Highlands County Area within the District. The estimated citrus acreages in the Highlands County Area are shown in **Table F-14**.

Citrus Nursery

The Highlands County Area is the only county area with significant citrus nursery acreage. Ordinary least squares regression analysis was used to project citrus nursery acreage in Highlands County as a function of Highlands County citrus acreage and a time trend variable. The model estimate took the general form of **Equation F-34**.

$$A_t = f(Y, d) \qquad (F\text{-}34)$$

where:

A_t = *citrus nursery acreage in Highlands County in year t*

Y = *numeric value of the year under consideration (for example Y = 1975 in 1975)*

d = *a dichotomous variable equal to one from 1974 to 1978 inclusive and zero otherwise*

The functional form represented in **Equation F-34** was estimated using ordinary least squares regression analysis, resulting in **Equation F-35**.

$$A_t = -21458.3 + 10.92 * Y - 37.77 * d \qquad (F\text{-}35)$$

$$(8.19) \quad (-2.03)$$

<u>Goodness of fit statistics</u>

$R^2 = .8801$
$F = 69.76$
$Pr\ F > 0 > .999$
t-statistics in parentheses
$D\text{-}W = 1.93$

Equation F-35, adjusted for the actual 1994 acreage, was used to make the primary citrus nursery acreage projections by applying the primary citrus acreage projections derived above.

To generate estimates of citrus nursery acreage in the Highlands County Area, it was assumed that changes in crop acreage will be proportional to the most recently reported acreage ratio between the two districts. The local IFAS extension office estimates that approximately 10 percent of the citrus nurseries in Highlands County are in the SFWMD and this estimate was used to make projections for the Highlands County Area.

The estimated citrus nursery acreages in Highlands County and the Highlands County Area for the six time horizons are shown in **Table F-15**.

Table F-15. Historical Citrus Nursery Acreage in the Highlands County Area.

Year	Historical
1972	84
1973	88
1974	100
1975	72
1976	66
1977	55
1979	83
1980	108
1981	172
1982	183
1983	144
1984	224
1985	198
1986	249
1987	288
1988	268
1989	207
1990	314
1991	305
1992	324
1993	284
1994	276
1995	287

Okeechobee County Area

Citrus acreage is increasing in Okeechobee County. When **Equations F-12** through **F-19** were estimated using ordinary least squares regression the results shown in **Equations F-36** through **F-43** were obtained.

$$OKEECIT_t = 3629.19 + 164.3937 * time - 54.4395 * RP_p + 69.9666 * RP_w - 224.6156 * RP_o + 2382.359 * d(\quad (F\text{-}36)$$

(2.38) (-0.19) (0.32) (-1.10) (2.72)

where:

D = a dichotomous variable equal to zero in 1980 and before and one after 1980.

Goodness of fit statistics

R^2 = .9526
F = 36.14
Pr F>0>.999
D-W = 1.22
t-statistics in parentheses

$$WTOKEEt = - 468.8769 + 307.2401 * time - 44.417 * RPp + 293.675 * RPw - 397.464 * RPo + 1578.984 * d \quad (F\text{-}37)$$

(2.89) (-0.10) (0.90) (-1.27) (1.17)

Goodness of fit statistics

R^2 = .9309
F = 24.26
Pr F>0>.999
D-W = 0.778
t-statistics in parentheses

$$OKEECIT_t = 2115.318 + 201.382 * time + 1941.607 * d \quad (F\text{-}38)$$

(4.70) (2.61)

Goodness of fit statistics

R^2 =.9473
F = 100.59
Pr F>0>.999
D-W = 0.765
t-statistics in parentheses

$$WTOKEE_t = -1481.958 + 323.8302 * time + 1110.425 * d \qquad (F\text{-}39)$$

$$(4.88) \qquad (0.96)$$

<u>*Goodness of fit statistics*</u>

R^2= .9167
F= 66.04
Pr F>0>.999
D-W=0.365
t-statistics in parentheses

$$OKEECIT_t = 1014.923 + 314.3923 * time + 42.976 * RP_p + 125.953 * RP_w - 93.180 * RP_o \qquad (F\text{-}40)$$

$$(5.90) \qquad (0.12) \qquad (0.46) \qquad (-0.36)$$

<u>*Goodness of fit statistics*</u>

R^2 = .9135
F = 26.41
Pr F >0 > .999
D-W = 1.162
t-statistics in parentheses

$$WTOKEE_t = -2201.565 + 406.6564 * time + 20.147 * RP_p + 330.7824 * RP_w - 310.352 * RP_o \qquad (F\text{-}41)$$

$$(6.25) \qquad (0.04) \qquad (1.00) \qquad (-1.00)$$

<u>*Goodness of fit statistics*</u>

R^2 = .9203
F = 28.88
Pr F > 0 >.999
D-W = 0.820
t-statistics in parentheses

$$OKEECIT_t = 1565.196 + 298.4625 * time \qquad (F\text{-}42)$$

$$(11.57)$$

Goodness of fit statistics

$R^2 = .9116$
$F = 134.00$
$Pr\ F>0>.999$
$D\text{-}W = 0.937$
t-statistics in parentheses

$$WTOKEE_t = -\ 1796.578 + 379.351 * time \qquad (F\text{-}43)$$

$$(11.48)$$

Goodness of fit statistics

$R^2 = .9102$
$F = 131.79$
$Pr\ F > 0 > .999$
$D\text{-}W = 0.412$
t-statistics in parentheses

Equations F-36 through **F-43** were used to project citrus acreage in Okeechobee County. To generate estimates of citrus acreage in the Okeechobee County Area, it was assumed that changes is crop acreage will be proportion to the current acreages within the two districts.

The most recent District land use maps (1986-1988) show that approximately 90 percent of the citrus mapped in Okeechobee County was within the District, and 68 percent of this acreage in the District was within the Okeechobee County Area. These ratios were used to divide acreage projections, and the estimated citrus acreages are shown in **Table F-16**.

Table F-16. Historical Citrus Acreage in the Okeechobee County Area.

Year	Historical
1966	2,508
1968	3,329
1970	3,597
1972	3,676
1974	4,087
1976	4,162
1978	4,171
1980	4,281
1982	6,954
1984	8,044
1986	7,449
1988	8,124
1990	8,541
1992	10,439
1994	11,270
1995	11,623

Glades County Area

Citrus acreage is increasing in Glades County. **Equations F-12** through **F-19** were estimated for Glades County citrus acreage and resulted in **Equations F-44** through **F-51**.

where:

D = a dichotomous variable equal to zero before 1970 and one in the period 1970 and after.

$$GLCIT_t = -835.3118 + 400.94 * time - 412.0758 * RP_o + 254.319 * RP_w + 406.0648 * RP_p - 2388.293 * d \quad (F\text{-}44)$$

(10.55) (-2.30) (1.30) (1.61) (-3.39)

Goodness of fit statistics

$R^2 = .9643$
$F = 48.66$
$Pr\ F > 0 > .999$
t - statistics in parentheses
D-W = 1.89

$$WGLCITt = -464.5248 + 408.2684 * time - 547.5291 * RPo + 259.1371 * RPw + 295.6929 * RPp - 2843.594 * d \qquad (F\text{-}45)$$

(8.64) (-2.46) (1.05) (0.94) (-3.25)

Goodness of fit statistics

$R^2 = .9523$
$F = 35.98$
$Pr\ F > 0 > .999$
$D\text{-}W = 1.73$
t - statistics in parentheses

$$GLCIT_t = 715.4822 + 360.7589 * time - 2317.46 * d \qquad (F\text{-}46)$$

(12.59) (-3.18)

Goodness of fit statistics

$R^2 = .9394$
$F = 93.08$
$Pr\ F > 0 > .999$
$D\text{-}W = 1.18$
t - statistics in parentheses

$$WGLCIT_t = -669.5979 + 384.7645 * time - 2516.91 * d \qquad (F\text{-}47)$$

(10.76) (-2.76)

Goodness of fit statistics

$R^2 = .9186$
$F = 67.74$
$Pr\ F > 0 > .999$
$D\text{-}W = 0.72$
t - statistics in parentheses

$$GLCIT_t = -3943.802 + 382.4059 * time - 361.0439 * RP_o + 419.2195 * RP_w + 457.4512 * RP_p \quad \text{(F-48)}$$

(7.09) (-1.41) (1.53) (-1.27)

<u>Goodness of fit statistics</u>

$R^2 = .9185$
F = 23.20
Pr F > 0 >.999
D-W = 0.80
t - statistics in parentheses

$$WGLCIT_t = -4165.612 + 386.201 * time - 486.7685 * RP_o + 451.9017 * RP_w + 356.8755 * RP_p \quad \text{(F-49)}$$

(5.90) (-1.57) (1.35) (0.81)

<u>Goodness of fit statistics</u>

$R^2 = .8963$
F = 21.62
Pr F > 0 > .999
D-W = 0.65
t - statistics in parentheses

$$GLCIT_t = -486.0107 + 306.9607 * time \quad \text{(F-50)}$$

(10.17)

<u>Goodness of fit statistics</u>

$R^2 = .8883$
F = 103.46
Pr F > 0 > .999
D-W = 0.42
t - statistics in parentheses

$$WGLCIT_t = -\ 1974.499 + 326.3361 * time \qquad (F\text{-}51)$$

$$(9.19)$$

<u>Goodness of fit statistics</u>

$R^2 = .8666$
$F = 84.47$
$Pr\ F > 0 > .999$
$D\text{-}W = 0.26$
t - statistics in parentheses

The most recent District land use maps (1986-1988) show that 31 percent of the citrus acreage in Glades County is within the KB Planning Area. This ratio was used to divide acreage projections, and the estimated citrus acreages are shown in **Table F-17**.

Table F-17. Historical Citrus Acreage in the Glades County Area.

Year	Historical
1966	1,413
1968	1,461
1970	1,572
1972	1,639
1974	1,661
1976	1,615
1978	1,613
1980	3,395
1982	4,026
1984	5,141
1986	6,076
1988	6,235
1990	7,523
1992	9,136
1994	9,270
1995	9,675

The acreage ratio of the three different types of irrigation systems in 1991 in use for citrus was assessed from District permits. Permitted citrus acreage (as of March 1991) in Glades County had irrigation systems in the ratio shown in **Table F-18**.

Table F-18. Ratio of Permitted Irrigation System Type on Citrus in Glades County.

Type of System	Percent of Permitted citrus	Estimated Efficiency
Micro irrigation	77	0.85
Overhead sprinkler	3	0.75
Seepage	20	0.50

Vegetables

Commercial vegetables are produced in the Osceola, Polk, Highlands, and Okeechobee county areas. There is a small amount of vegetable production in Glades County outside the KB Planning Area. Vegetable crops include squash, cucumbers, peppers, tomatoes, watermelons, potatoes, and latin vegetables.

Osceola County Area

Vegetable production in Osceola County is relatively small, and there is very limited data available on historical production. Empirical knowledge of agricultural production in Osceola County provided by the local IFAS extension office was considered the best source for projection purposes.

Vegetable crops grown in Osceola County are grown interchangeably, and double cropped. Although the location of specific vegetable crops varies from year to year, the total acreage of vegetables production is quite stable, and has been estimated at 1,200 acres per year by IFAS for the entire county, all of this acreage within the District. The primary projection for vegetable production in the Osceola County Area is at 1,200 acres, and the primary range from 1,020 to 1,380 acres. **Table F-19** shows the supplemental water requirements and irrigation requirements for vegetable crops using a generalized cultivation schedule which is weighted for all the relevant crops, and an irrigation efficiency of 50 percent.

Table F-19. Supplemental Water Requirements, Generalized Cultivation Schedule and Irrigation Requirements for Vegetable Crops in the Osceola County Area.

Rainfall Station = Kissimmee: Soil Type = 0.8 in: Acreage = 1,200: Efficiency = 50%.					
Month	**Average (in.)**	**2-in-10 (in.)**	**Approx. Percent in Ground**	**Average (mg)**	**2-in-10 (mg)**
January	1.11	1.27	50	36	41
February	0.92	1.11	100	60	73
March	1.58	1.80	100	103	117
April	2.40	2.60	100	156	170
May	2.78	3.08	50	90	100
June	1.82	2.34	0	0	0
July	1.98	2.53	0	0	0
August	2.10	2.59	50	68	84
September	1.66	2.11	100	108	138
October	1.92	2.19	100	125	143
November	1.72	1.87	100	112	122
December	1.21	1.36	50	39	44
Total	21.18	24.84		898	1,031

Polk County Area

Watermelons are the only vegetable crops grown commercially in the Polk County Area, and are generally grown once a year between January and May. Cultivation primarily takes place on sandy soil with a usable soil moisture capacity of 0.8 in., and uses seepage irrigation systems with an estimated irrigation efficiency of 50 percent. Production does not take place on the same land each year due to the viral infestation which occurs in fields after one season of production. The local IFAS extension office estimates that there are approximately 500 acres of land used for watermelon production each year in Polk County Area, and this is forecast to remain fairly constant through 2010.

Table F-20. Supplemental Water Requirements, Generalized Cultivation Schedule and Irrigation Requirements for Vegetable Crops in the Polk County Area.

Rainfall Station = Avon Park: Soil Type = 0.8 in: Acreage = 500: Efficiency = 50%.					
Month	**Average (in)**	**2-in-10 (in)**	**Approx. Percent in Ground**	**Average (mg)**	**2-in-10 (mg)**
January	1.39	1.53	50	19	21
February	1.17	1.34	100	32	36
March	1.96	2.14	100	53	58
April	2.47	2.67	100	67	73
May	2.69	3.00	50	37	41
Total	21.71	25.31		207	229

Highlands County Area

Watermelon is a significant vegetable crop grown commercially in Highlands County, and therefore production does not take place on the same land each year. Although the location varies from year to year, the total acreage of watermelon production is quite stable, and has been estimated at 750 acres per year by IFAS for the entire county, approximately half of which takes place within the District. The primary projection for vegetable production in the Highlands County Area is at its 1990 level of 375 acres, and the primary range from 319 to 431 acres. Watermelons in the Highlands County Area are generally grown once a year between January and May, following the schedule shown in **Table F-21**. Watermelons in the Highlands County Area are grown using seepage irrigation on sandy soil.

Table F-21. Supplemental Water Requirements, Generalized Cultivation Schedule and Irrigation Requirements for Vegetable Crops in the Highlands County Area.

Rainfall Station = Lake Placid: Soil Type = 0.8 in: Acreage = 375: Efficiency = 50%.					
Month	**Average (in)**	**2-in-10 (in)**	**Approx. Percent in Ground**	**Average (mg)**	**2-in-10 (mg)**
January	0.88	1.01	50	9	10
February	1.18	1.35	100	24	27
March	2.62	2.82	100	53	57
April	2.50	2.74	100	51	56
May	2.36	2.65	50	24	27
Total	9.54	10.57		161	178

Okeechobee County Area

Watermelons, potatoes, and a small amount of latin vegetables are the vegetable crops presently grown commercially in Okeechobee County. In 1990 there were 665 acres used for vegetable production, and this vegetable acreage is forecast to remain at that level through 2010. All of the vegetable crops grown commercially in Okeechobee County are grown within the KB Planning Area. The supplemental water requirements, generalized cultivation schedule and irrigation requirements for vegetable crops in the Okeechobee County Area are shown in **Table F-22**.

Table F-22. Supplemental Water Requirements, Generalized Cultivation Schedule and Irrigation Requirements for Vegetable Crops in the Okeechobee County Area.

Rainfall station = Okeechobee: Soil type = 0.8 in: Acreage = 665: Efficiency = 50%.					
Month	**Average (in.)**	**2-in-10 (in.)**	**Approx.% in ground**	**Average (mg)**	**2-in-10 (mg)**
January	0.95	1.07	80	27	31
February	1.13	1.27	100	41	46
March	2.05	2.27	80	59	66
April	3.28	3.52	70	83	89
May	4.17	4.51	30	45	49
June	3.34	3.93	0	0	0
July	3.97	4.53	0	0	0
August	4.03	4.54	0	0	0
September	2.62	3.16	0	0	0
October	2.43	2.78	60	53	60
November	2.22	2.33	60	48	50
December	1.35	1.45	60	29	31
Total	31.54	35.36		386	422

Sod

Sod is harvested from both irrigated and non-irrigated fields. Non-irrigated sod production usually entails the harvesting of sod from land which is normally used for pasture. This non-irrigated sod is not quantified in this report as no water is added to supplement rainfall.

Irrigation requirements are calculated for irrigated sod. Irrigated sod is produced commercially in the Osceola, Polk, Highlands, and Okeechobee county areas. Sod is also produced in Glades County outside the KB Planning Area.

Irrigated sod acreage estimates were obtained from the local IFAS extension offices in each county for 1995. No meaningful trend could be identified due to the lack of historical sod acreage data in each county area, and acreage was projected to remain relatively constant through the year 2020.

Table F-23. Irrigated Sod Production in Kissimmee Basin Planning Area.

County Area	Irrigated sod acreage	Rainfall station	Soil type (in.)	Irrigation Efficiency
Osceola	500	Kissimmee	0.8	75%
Polk	1,000	Avon Park	0.8	50%
Highlands	900	Lake Placid	3.6	50%
Okeechobee	250	Okeechobee	0.8	50%
Total	2,650			

Blueberries

The Highlands County Area is the only county region in the KB Planning Area in which blueberries are grown commercially. Blueberry production is a relatively new industry in Highlands County, and appears to be well suited to local conditions. IFAS is presently promoting blueberry production in Highlands County and there are several growers expressing active interest in producing this crop.

The local IFAS extension office estimates that there were 100 acres of blueberry production in Highlands County in 1990, all within the KB Planning Area. This number has increased to 300 acres in 1995, 200 of which are in the KB Planning Area. Blueberry acreage in Highlands County is forecast to increase by 150 acres every five years through the year 2010, two thirds of which is anticipated to be within the KB Planning Area. **Table F-24** shows the blueberry acreage for the Highlands County Area over the projection period.

Currently the District's modified Blaney-Criddle permitting model has no category for blueberries. The crop with characteristics most like blueberries for which the District does have a permitting category is citrus. Blueberries in Highlands County are grown on sandy soil with a usable soil moisture capacity of 0.8 in. and use micro irrigation systems with an estimated irrigation efficiency of 85 percent. These water requirements were applied to the blueberry acreage projections to calculate the irrigation requirements shown in **Table F-24**.

Table F-24. Projected Blueberry Acreage for the Highlands County Area.

	1985	1990	1995	2000	2005	2010
Acreage	0	100	200	300	400	500

Caladiums

The Highlands County Area is the only county region in the KB Planning Area in which caladiums are grown commercially. Highlands County produces over 90 percent of the world's caladium bulbs. The acreage used by this industry has stabilized and IFAS believes that the acreage will probably remain relatively constant through 2020. Currently there are between 1,100 and 1,200 acres of land used annually for caladium production. This acreage is not included as nursery acreage by the Division of Plant Industry (DPI). The primary projection for the six time horizons is 1,150 acres, and the primary range is from 977 to 1,322 acres. Practically all of this acreage exists within the boundaries of the District.

Currently the District's modified Blaney-Criddle permitting model has no category for caladiums, and the value for grass is used for permitting purposes. Caladiums in the Highlands County Area are currently grown on muck soil with a usable soil moisture capacity of 3.6 in. Supplemental water requirements for grass on soil with a 3.6 in. soil water holding capacity in Highlands County were applied to the caladium acreage projection of 1,150 acres to calculate the irrigation requirements shown in **Table F-25**. Caladium farms in Highlands County use sprinkler systems for irrigation with an estimated irrigation efficiency of 75 percent. Planting usually takes place in April, and about one-third of the acreage is harvested in each of the months of November, December and January. This means that in February and March, caladium fields are usually vacant.

Table F-25. Supplemental Water and Irrigation Requirements for Caladiums in the Highlands County Area.

Rainfall Station = Lake Placid: Soil type = 3.6 in: Acreage = 1,150: Efficiency = 75%.					
	Average (in.)	**2-in-10 (in.)**	**Percent in Ground**	**Average (mg)**	**2-in-10 (mg)**
January	0.58	0.76	33	8	10
February	0.55	0.79	0	0	0
March	1.83	2.11	0	0	0
April	2.70	3.06	100	112	127
May	3.72	4.18	100	155	174
June	1.44	2.35	100	60	98
July	1.94	2.83	100	81	118
August	2.36	3.15	100	98	131
September	1.29	2.05	100	54	85
October	1.99	2.40	100	83	100
November	1.72	1.90	100	72	79
December	1.08	1.22	66	30	34
Total	21.20	26.80		752	957

Ornamental Nursery

Commercial ornamental nursery plants are produced in the Orange, Osceola, Highlands, and Okeechobee county areas. There are ornamental nurseries in Polk and Glades county outside the KB Planning Area.

Currently the District’s modified Blaney-Criddle permitting model has no category of ornamental nursery, and the value for grass is used for permitting purposes. The majority of ornamental nurseries in the KB Planning Area use sprinkler systems for irrigation. Normally, sprinkler irrigation systems are estimated by the District to have an irrigation efficiency of 75 percent. However, an indeterminable number of nurseries containerize their plants, and this reduces the irrigation efficiency to approximately 20 percent. To account for this range of efficiencies, an overall irrigation efficiency of 50 percent was assumed for historic acreage. Micro irrigation systems will be required on all new container nursery projects, raising the estimated efficiency of these projects to 85 percent, and the post 1993 overall average efficiency to 80 percent (SFWMD, 1993). This often means that, even with increased acreage, the overall ornamental nursery irrigation demands are reduced.

A model of the form shown in **Equation F-52** was used to estimate ornamental nursery acreage.

$$ORN_t = f(YEAR_t, D) \tag{F-52}$$

where:

ORN_t = *Ornamental nursery acreage in a county in year t.*

$YEAR$ = *numeric value of the year under consideration (e.g., year = 1976 for 1976).*

D is a dichotomous variable equal to one in a year experiencing a major one-time increase in acreage, zero otherwise.

Equation F-52 was initially estimated for each county empirically using ordinary least squares (OLS). If the OLS method did not yield a satisfactory statistical fit and/or reasonable acreage projections then the robust regression method was used to develop county projections. If the robust regression method did not yield a satisfactory statistical fit and/or reasonable acreage projections then more complex regression methods were used to develop projections.

For Okeechobee and Osceola counties, neither ordinary least squares nor robust regression yielded models which adequately captured the highly non-linear pattern of ornamental nursery growth. For Okeechobee County, a model of the form shown in **Equation F-53** was estimated.

$$ORN_t = f(time_t, D, logtime_t) \quad (F\text{-}53)$$

This formulation allows for a non-linear growth pattern in acreage, beyond the piecewise linear pattern implied by **Equation F-52**. For Osceola County, there has not been a distinct linear pattern to ornamental nursery acreage. Rather there was a period of irregular increase through 1989 and a pattern of irregular decline thereafter. Major freeze events are thought to play a major role in this pattern, but the issue is complicated by the uneven pattern of ornamental nursery growth and decline in Osceola County. Given this pattern, an auto regressive moving average model such as that shown in **Equation F-54** was estimated.

$$ORNt = ø1ORNt\text{-}1 + \ldots + øpORNt\text{-}p + a1 - q1at\text{-}1 \ldots - qqat\text{-}q. \quad (F\text{-}54)$$

where:

ø's are auto regressive parameters

q's are the moving average parameters

a's are random error terms

In order to calibrate model projections to 1995 data, the residual between the predicted value and the observed value for 1995 was added to the projections derived from the projection equations.

Orange County Area

Ornamental nursery acreage in Orange County increased from 682 acres in 1972 to 1,319 acres in 1987. Between 1987 and 1995 this growth has leveled, with slight variations from year to year. **Equation F-52** was estimated empirically using ordinary least squares, the results shown in **Equation F-55** were obtained.

$$ORNt = 685.3262 + 35.7630 * YEARt - 143.2196 * D \quad (F\text{-}55)$$

$$(11.03) \qquad (-3.00)$$

Goodness-of-fit statistics

$R^2 = .9165$
$F = 155.26$
$Pr\ F > 0 > .999$
$D\text{-}W = 1.394$
t - statistics in parentheses.

The local IFAS extension office estimates that about one-fourth of the ornamental nursery acreage in Orange County is within the SFWMD. This estimate was used for all time horizons to develop the demand

Osceola County Area

Between 1972 and 1989, Osceola County ornamental nursery acreage grew from approximately 30 acres to 498 acres. From 1989 to 1995, nursery acreage in Osceola County declined continuously. **Equation F-56** was estimated using the auto regressive moving average estimation technique as described in **Equation F-54**. Rather than R-squared, a different goodness of fit statistic is applicable to the ARIMA model, pseudo R-squared. Pseudo R-squared is calculated as one minus the ratio of the error sum of squares for the model under consideration to the error sum of squares for the (0,0) model, a constant predictor at the mean of the series. Neither the mean of the series nor a time-trend was fit. For this model, one auto regressive term is used (ø=1), as shown in **Equation F-56**.

$$OSCNUR_t = .9607 * OSCNUR_{t-1} \qquad (F\text{-}56)$$

Goodness-of-fit statistics:

Pseudo R-Squared = 80.99026
Residual sum of squares = 110627.1
Root Mean Square Error = 70.91194

In order to calibrate the model projections to historic 1995 data, the residual between the predicted value and the observed value for 1995 (3 acres) was subtracted from the projections derived from equation H-51.

All the ornamental nursery acreage in Osceola County is within the SFWMD. Supplemental water requirements using rainfall and ET data at the Kissimmee rainfall station for grass on soil with a 0.8 in. soil water holding capacity were applied to the primary ornamental nursery acreage.

Highlands County Area

When **Equation F-52** was estimated empirically using ordinary least squares, the results shown in **Equation F-57** were obtained.

$$ORNt = 169.4499 + 4.1198 * YEARt + 1256.606 * D \qquad (F\text{-}57)$$

$$(1.04) \qquad (19.81)$$

<u>Goodness-of-fit statistics</u>

$R^2 = .9756$
$F = 340.21$
$Pr\ F > 0 > .999$
$D\text{-}W = 1.557$
t - statistics in parentheses.

Equation F-57 adjusted for the 1995 acreage was used to develop the projections. The local IFAS extension office estimates that about one-fifth of the ornamental nursery acreage in Highlands County is within the SFWMD.

Okeechobee County Area

When **Equation F-54** was estimated empirically using ordinary least squares, the results shown in **Equation F-58** were obtained.

$$ORN_t = 17.6485 + 19.3803 * TIME_t - 80.7765 * logTIME_t + 335.442 * D \qquad (F\text{-}58)$$

$$(2.95) \qquad (-1.70) \qquad (6.67)$$

where:

time = *one in 1968 and increases one unit per year thereafter*

Logtime = *natural log of time*

D = *one for 1992 and after*

<u>Goodness-of-fit statistics</u>

$R^2 = .9238$
$F = 76.88$
$Pr\ F > 0 > .999$
$D\text{-}W = 1.888$
t - statistics in parentheses.

Equation F-58 adjusted for the 1995 acreage was used to develop the projections. All of the ornamental nursery acreage in Okeechobee County is within the SFWMD, and the demand projections for all time.

Cattle Watering

Water required for cattle watering was calculated as a function of the number and type of cattle (beef or dairy). Demand is based on the District allocated amount of 12 gal/

cow/day for beef cattle, and 185 gal/cow/day for dairy cattle (35 gal/cow/day for drinking and 150 gal/cow/day for barn washing). Demand levels for cattle watering in the KB Planning Area are kept constant throughout the projection period.

Table F-26. Cattle Watering in the Kissimmee Basin Planning Area.

County Area	Year	Total Head of Cattle	Total Head Dairy Cattle	Total Head Beef Cattle	MGD	MGY
Orange	1990	1,450	0	1,450	0.02	6
Osceola	1990	60,600	0	60,600	0.73	265
Polk	1990	35,909	500	35,409	0.52	189
Highlands	1990	98,100	8,100	90,000	2.58	941
Okeechobee	1990	98,100	32,643	106,723	7.32	2,672
Glades	1990	45,160	850	44,310	0.69	251
Total Planning Area	1990	339,319	42,093	338,492	11.85	4,325

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